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ENERGY INDUSTRY STUDY
June 1, 2005

ABSTRACT: Energy is one of the most important sectors of the U.S. national economy, and reliable energy resources are critical to the national security of the United States. The USG should create market incentives to encourage investment, development, and deployment of a broad portfolio of renewable alternative energy supplies and enhanced conservation measures to reduce the rapid growth rate of U.S. reliance on imported energy and reduce the environmental consequences as U.S. energy usage increases. Federal efforts should supplement market incentives to help determine the most efficient portfolio from among such technologies as clean coal, solar, wind, hydrogen, deep earth, nuclear, and other technologies. In addition, the USG should develop regulatory mechanisms to increase reliability, security, and environmental standards to minimize the potential impacts of natural disasters, terrorism, or economic disruption while using market incentives to control cost growth.

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PLACES VISITIED:

Domestic Field Studies				
Date	**Host**	**Business/Role/Project**	**Primary POC**	**Website**
02/04/05	Wheelabrator Technologies, Baltimore, MD	Wheelabrator Technologies (wholly owned subsidiary of Waste Management, Inc) owns and/or operates 17 waste-to-energy facilities	Mr. Lou Demley	www.wheelabratortechnologies.com
02/04/05	H2Gen Innovations Inc., Alexandria, VA	Manufactures Hydrogen Generator Modules (HGM) which generate hydrogen from natural gas and water	Sandy Thomas	www.h2gen.com
02/18/05	Department of Energy, D.C.	Energy Strategic Goal: To protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy.	William Parks	http://www.energy.gov/engine/content.do?BT_CODE=DOEHOME
03/03/05	Mirant's Dickerson Electricity Generating Facility Dickerson, MD	Coal power plant	Doug Lewis	http://www.mirant.com/
03/04/05	CONSOL Energy, Morgantown, WV	Coal mine (longwall mining)	Elizabeth Chamberlin	http://www.consolenergy.com/
03/17/05	BP Solar Headquarters, Linthicum, MD	Manufactures photovoltaic power modules	Jean Poulin	www.bpsolar.com
03/18/05	Peach Bottom Nuclear Plant, Delta, PA 17314	Nuclear Power Plant	Pat Bolling	http://www.exeloncorp.com/generation/library/pdf/peachbottom04-05.pdf
03/18/05	Conowingo Hydroelectric Plant, Conowingo, MD	Hydropower Plant	Pat Bolling	http://library.thinkquest.org/17531/conowingo.html%3ftqskip=1
04/08/05	Pepco Control Center	Regional Electrical Control Center	Wally Johnson	n/a
04/08/05	CIA, McClean, VA	OCONUS energy market intelligence	Terry Coyne	http://www.cia.gov/

04/11/05	Pacific Gas and Electric (PG&E), San Francisco, CA	Combined natural gas and electric utility provider for northern and central CA	Ron Shaw	http://www.pge.com/
04/11/05	California Public Utilities Commission (CPUC), San Francisco, CA	Energy industry regulator	Steve Weissman	http://www.cpuc.ca.gov/
04/12/05	Chevron Corporation, San Francisco, CA	Refinery	Carol McCauley	http://www.chevron.com/
04/13/05	Independent Institute, San Francisco, CA	Libertarian think tank	David Theroux	http://www.independent.org/
04/13/05	Pacific Institute, San Francisco, CA	Think tank - water and energy	Gary Wolff	http://www.pacinst.org/
04/15/05	Exxon/Mobile, Santa Barbara, CA	Processing plant and oil platform visit	Michael Parker	http://www.exxonmobil.com/corporate/
05/05/05	Australian Embassy, D.C,	Briefing on Australia	Paul Kay	http://www.austemb.org/

International Travel – Australia

Date	**Host**	**Business/Role/Project**	**Primary POC**	**Website**
05/10/05	National Electricity Market Management Company Limited (NEMMCO), Sydney, NSW, AU	Market Operator & System Operator	Murray Chapman	http://www.nemmco.com.au/
05/10/05	University of New South Wales Centre for Energy and Environmental Markets (CEEM), Sydney, NSW, AU	Research of energy and environmental markets	Dr. Tony Owen	http://www.ceem.unsw.edu.au/Index.cfm
05/11/05	Department of Energy, Utilities and Sustainability (DEUS), Sydney, NSW, AU	Regulator: energy and urban water in New South Wales	Mal Williams	http://www.deus.nsw.gov.au/about/index.htm
05/11/05	EnviroMission	Australian Solar Tower Project (proposed 200MW power station)	Dr. Martin Thomas	http://www.ceem.unsw.edu.au/Index.cfm

05/12/05	Port Waratah Coal Services Limited (PWCS), Newcastle, NSW, AU	Owns and operates Port Waratah Coal facility, world's largest coal handling operation	Carmen Griffiths	http://www.pwcs.com.au/about_us.html
05/12/05	Newcastle Port Corporation, Newcastle, NSW, AU	Manages Port of Newcastle	Keith Powell	http://www.newportcorp.com/
05/16/05	U.S. Embassy, Canberra, NSW, AU	U.S. Embassy	COL Michael Mahar	http://canberra.usembassy.gov/history.html
05/16/05	Australian Department of Foreign Affairs and Trade (DFAT), Canberra, NSW, AU	Department's aim is to advance the interests of Australia and Australians internationally	David Stuart	http://www.dfat.gov.au/
05/16/05	Sustainable Energy Systems (CSES), Australian National University, Canberra, NSW, AU	"Big Dish" – Solar power with thermal energy storage, enables "dispatchable" solar energy	Dr. Keith Lovegrove	http://solar.anu.edu.au/index.html
05/17/05	Australian Bureau of Agricultural and Resource Economics (ABARE) , Canberra, NSW, AU	Australian government economic research agency conducting independent research and analysis.	Graham Love	http://www.abare.gov.au/
05/18/05	Victoria Department of Infrastructure, Melbourne, VIC, AU	Provider of essential infrastructure in Victoria, with responsibility for transport, ports and marine, freight, information and communication technology (ICT), major development, energy and security.	Sonya Spencer	http://www.doi.vic.gov.au/
05/18/05	Ceramic Fuel Cells Limited (CFU) , Melbourne, VIC, AU	Developing ceramic solid oxide fuel cells for stationary power (electricity) requirements	David Peck	http://www.cfcl.com.au/
05/19/05	Loy Yang Power, VIC, AU	Power generator/marketer	Dale Dunn	http://www.loyyangpower.com.au/ www.powerworks.com.au/

INTRODUCTION

Energy is one of the most important sectors of the U.S. national economy and reliable energy resources are critical to the national security of the United States. The U.S. energy industry plays a major strategic role for both the U.S. economy and U.S. national security.

Power generation and transportation demands are increasing rapidly with the growing economy. Over the next 20 years, U.S. petroleum requirements will increase by 33%, natural gas consumption by well over 50%, and demand for electricity by 45%. The imbalance between the U.S. domestically available supply and its ability to meet demand jeopardizes the U.S. economy, standard of living, and national security.[1] Existing and newly discovered domestic oil and gas reserves alone are incapable of meeting projected US energy needs. Therefore, unless the U.S. undertakes a major federal effort to develop new energy resources, the U.S. will remain reliant on domestic coal and imported oil and natural gas. As U.S. and international energy resources are depleted, the costs of these resources will continue to climb for the foreseeable future.[2] In addition, the US energy infrastructure is aging and is becoming increasingly vulnerable to natural disasters, terrorism, and economic disruption.

The national and international energy market does not adequately allocate long-term costs associated with the environmental consequences and security requirements of energy resources. As national and international demand for energy continues to grow, the challenges posed by potential global climate change and the importance of affordable and reliable energy to national and international economies will increase sharply. Therefore, U.S. policymakers face a multitude of challenges to meet these demands to provide affordable energy while managing environmental, safety, security, and developmental goals and objectives.

The U.S. government must design creative solutions to supplement the energy market through incentives in order to manage these challenges. Left alone, the energy market would insure long-term supplies of energy, but at much higher prices and without accounting for environmental, safety, security, and developmental issues. The energy market requires limited federal intervention to control for natural monopolies such as infrastructure ownership, incomplete markets, information failures, business cycles, and externalities such as climate change, environmental concerns, energy security, and other social issues.

This paper represents the culmination of an intensive, five-month exploration of the energy industry by the sixteen graduate students and faculty members of the Industrial College of the Armed Forces Energy Industry Study Group. This study included both domestic research in California and West Virginia, and international research conducted in Australia, which provided case studies of the energy industry. In addition, each student contributed two separate individual research studies on the industry and on a specific economic issue associated with energy. Throughout this period, the group conducted seminars on specific issues and regional concerns associated with the energy industry.

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[1] National Energy Policy, pp. vii – x.

[2] See "Oil in Troubled Waters: A Survey of Oil," The Economist, April 30, 2005, p. 3.

THE INDUSTRY DEFINED AND ITS CURRENT CONDITION

In the course of its comprehensive review of the energy industry, this study focused on several particular aspects of the energy industry reflecting both the interests of the seminar participants and specific issues that the group determined would be appropriate for U.S. federal government attention.

The first aspect of the industry focuses on the transportation sector and its heavy reliance on oil. The study examined the potential for hydrogen fuel cell technology and biodiesel fuel to provide alternatives to oil. In addition, the seminar examined the potential development of the Arctic National Wildlife Refuge to provide additional domestic supplies of oil.

The second aspect of this industry study addressed the electricity-producing sector of the energy industry. The seminar paid particular attention to coal and clean coal technologies such as carbon sequestration. In addition, the participants closely examined the potential growth of solar energy, other renewable energy resources, and nuclear energy.

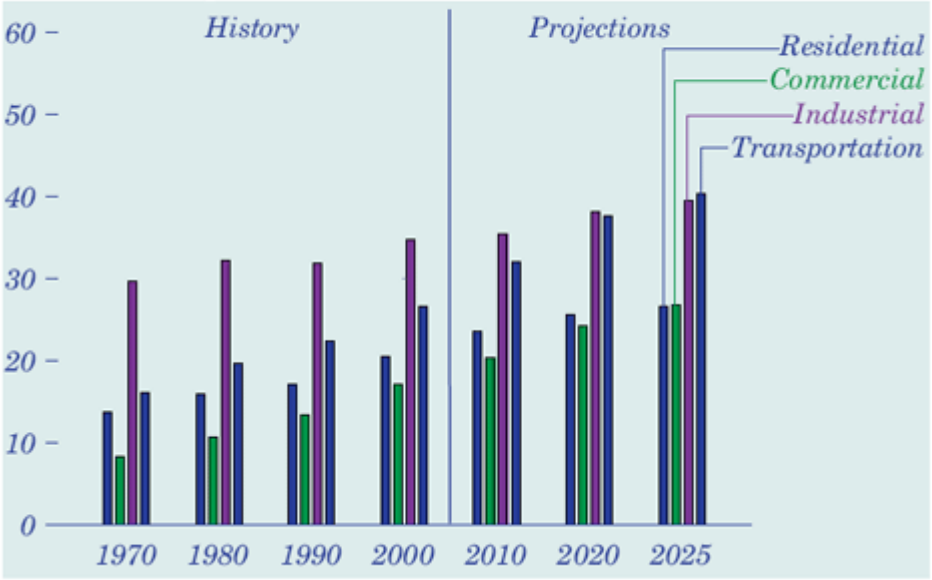
Third, this industry study highlighted two broad aspects of the energy industry – conservation and pipelines.

I. Transportation Sector

Transportation and Oil

The energy industry is comprised of four main sectors – transportation, commercial, residential, and industrial. In particular, energy consumption by the transportation sector has been growing rapidly, and transportation will likely emerge as the largest consumer of energy by 2025.

Figure 45. Primary energy consumption by sector, 1970-2025 (quadrillion Btu)



Source: Energy Information Administration, State Energy Data Report 2001, DOE/EIA-0214(2001) (Washington, DC, November 2004), and Annual Energy Review 2003, DOE/EIA-0384(2003) (Washington, DC, September 2004).

Given that this sector relies heavily on oil, transportation bears a major responsibility for the U.S. dependence on foreign oil supplies. According to the U.S. Energy Information Administration, 96% of the transportation industry is fueled by oil, consuming seven out of every ten barrels of oil the nation uses.[3] The United States uses about 20 million barrels of oil per day, at a cost of about $2 billion a week—much of this is to power highway vehicles.[4] In addition, 53% of all U.S. oil was imported in the year 2000 and oil import is projected to rise to 70% by 2025.[5] With prices for crude oil, coal, and natural gas sharply increasing, the demand for clean, green, and renewable energy technologies can only increase. According to a study by the Institute for the Analysis of Global Security, oil imports alone account for one-third of the total U.S. deficit and have cost the American people $3.4 trillion over the last 30 years.[6]

As the U.S. reliance on imported crude oil and refined fuels has continued to grow, interest in the national security concerns associated with U.S. reliance on imported oil has been renewed.[7] Suggested policy solutions to this challenge include increased fuel taxes, increasing the Corporate Average Fuel Economy requirements for automobile manufacturers to reduce demand and spur conservation, and increasing investment in research and development on hydrogen fuel cells and biodiesel fuel to provide an alternative means to support transportation. Those who support increased taxes argue that the true social costs of a fossil fuel-based economy should also include the billions of dollars of damage to the environment, and the public health costs associated with pollution. They believe that such tax increases can provide the market with incentives to reduce U.S. reliance on foreign energy supplies.

In addition, many political analysts argue that foreign dependence on oil is responsible for U.S. national security vulnerabilities that require significant defense expenditures to insure and protect those oil resources. They argue that national security interests require the U.S. to develop alternative energy resources to reform the current energy market.

Hydrogen

Due in part to a collective backing by government, automakers, and environmentalists; renewable, clean-burning hydrogen technology represents one potential technology to reduce our oil dependency on the Middle East. In 2004, the National Academies Committee on Alternatives and Strategies for Future Hydrogen

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[3] U.S. Energy Information Administration (EIA), 2003c, as quoted in Lovins, Amory B. et al. "Winning the Oil End Game. Innovations for Profits, Jobs and Security," Rocky Mountain Institute, Snowmass, CO. 2004, page 1.

[4] Department of Energy, www.eere.energy.gov/hydrogenandfuelcells.

[5] Amory B. Lovins et al., "Winning the Oil End Game. Innovations for Profits, Jobs and Security," Rocky Mountain Institute, Snowmass, CO. 2004, page 8.

[6] Julian Gresser & James Cusumano, "Hydrogen and the New Energy Economy: Why we need an Apollo Mission for Clean Energy," The Futurist, Washington: Mar/Apr 2005, Vol. 39, Iss. 2; p. 19 (7 pages).

[7] Robert Bryce, "As Green as a Neocon- Why Iraq hawks are driving Priuses," Slate, 25 Jan 2005, retrieved from: http://slate.msn.com/id/2112608/, 2 Apr 2005.

Production and Use declared, "A transition to hydrogen as a major fuel in the next 50 years could fundamentally transform the U.S. energy system, creating opportunities to increase energy security through the use of a variety of domestic energy resources for hydrogen production while reducing environmental impacts."[8]

With the current status of hydrogen technology development, unfortunately, it takes more energy to make hydrogen than it produces. Unless further research and development can reverse this net energy loss, hydrogen's reliance on fossil fuel for its production will prevent it from being an alternative to fossil fuels. Currently, hydrogen is difficult to produce, store, and transport, making it a non-viable source of alternative energy. As Alice Friedmann said in 2004, "Getting hydrogen using fossil fuels as a feedstock or an energy source is a bit perverse, since the whole point is to get away from them."[9] Both private and public investors continue to pursue research and development of more efficient methods to produce and distribute hydrogen fuel.

Biodiesel

Another potential solution to replace petroleum-based diesel fuels is to increase production of biodiesel fuels from vegetable oil. The primary demand incentive for biodiesel at the Federal level was created under the Energy Policy Act of 1992 (EPAct). This statute requires federal, state, and local government fleets to purchase alternative fueled vehicles such as ethanol, compressed natural gas, or electric. Congress amended the EPAct in 1998 to include biodiesel-fueled vehicles. This study concluded that this increase in biodiesel could be accommodated by a minimal increase of acreage committed to soybeans; have a minimal impact on consumer food prices; reduce dependency on imported oil and improve rural income by increasing demand for agricultural products.[10] Given the environmental and security advantages of biodiesel, it represents a logical alternative to replace as much petroleum-based diesel as possible. Enhancing the U.S. production of biodiesel from domestic biomass such as soybeans, can reduce this reliance by as much as 25% or up to 11 billion gallons annually.

The challenge to making biodiesel an alternative to petroleum-based diesel is that historically, biodiesel has been more expensive. Although this gap has been decreasing, as shown in the figure below, the price of petroleum-based diesel would need to rise further for biodiesel to be a viable alternative.[11] Even after various Federal tax credits are added, biodiesel is still more expensive to produce and ship than petroleum-based

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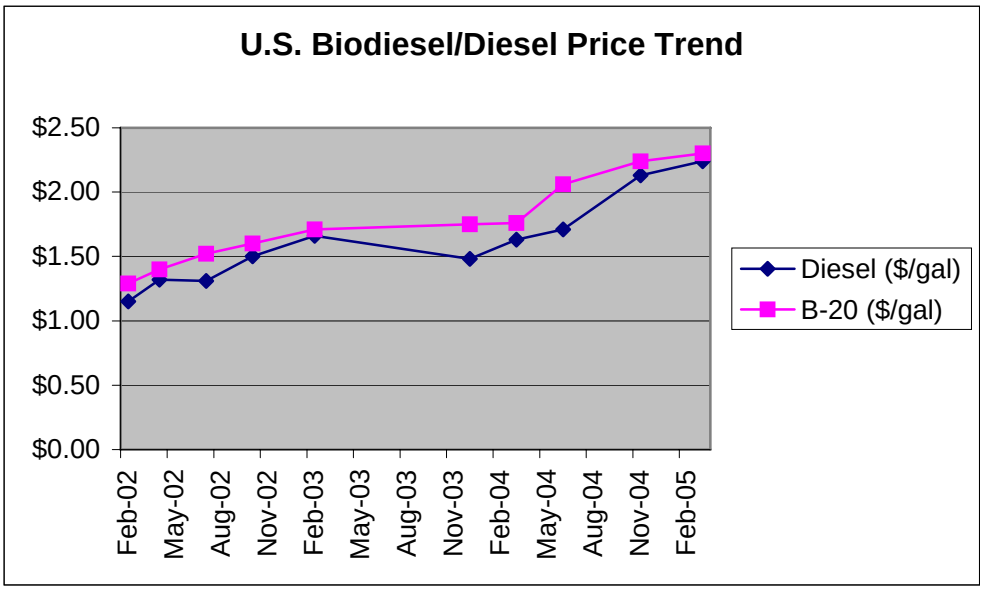
[8] Stephen Bennett, NPN, National Petroleum News Chicago: Jun 2004. Vol 96, Iss. 6, P.36-38

[9] Alice Friedmann, "The Hydrogen Economy – Energy and Economic Black Hole," Culture Change. September 2004. Accessed March 3, 2005 at http://www.culturechange.org/alt_energy.htm.

[10] John Urbanchuk; An Economic Analysis of Legislation for a Renewable Fuels Requirement for Highway Motor Fuels, Nov 2001; retrieved from: http://devafdc.nrel.gov/pdfs/6475.pdf, 28 Mar 05

[11] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, *Alternative Fuel Price Report, retrieved from:* http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html, April 3, 2005.



diesel.

Arctic National Wildlife Refuge (ANWR)

U.S. options to increase domestic supplies of oil and gas are extremely limited. While offshore exploration has some potential to find new supplies, the primary source of potential new supplies lies within the ANWR. Projected resources from ANWR, however, are not sufficient to eliminate U.S. reliance on foreign oil. Even the most optimistic projections for ANWR would only produce enough oil to reduce the growth in U.S. foreign oil dependence marginally.

Given the limited supplies that may be produced from ANWR, environmentalists argue that the environmental costs of developing the region outweigh the potential benefits. Nevertheless, after much debate, the U.S. Congress approved the development of oil production facilities within ANWR. Ultimately, Congress supported the Bush Administration's report on U.S. energy policy that recommended opening the ANWR to "environmentally regulated exploration and production," and earmarked $1.2B of ANWR bid bonuses to fund research of alternative and renewable energy resources.[12]

II. Electricity Generation

Coal

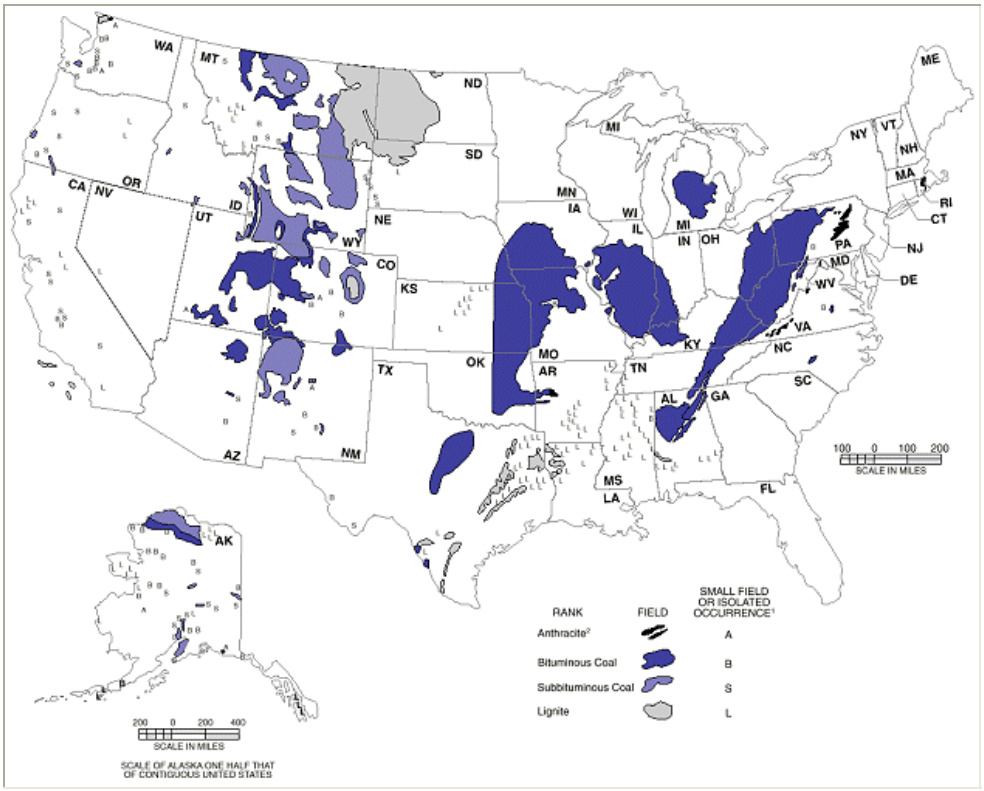
The U.S. coal industry has fueled the energy demands of economic prosperity for the United States throughout history due to its abundance and low cost as a source of electric energy. "The coal industry has become the Nation's largest energy-producing industry, representing nearly one-third of U. S. energy production. Coal also accounts for almost one-fourth of total energy consumed and is the only energy source for which exports are greater than imports. The coal industry is the Nation's leading mining industry, based on value of production."[13] "From an economic direct and indirect

[12] National Energy Policy, p. xiii-xiv.
[13] Web Site: www.eia.doe.gov, Energy Information Administration/Coal Data: A Reference, United States Coal: An Overview, p. 3.

impact, coal contributes $93.4 billion in business income, $46.5 billion in wages, $18.3 billion in federal taxes, $9.0 billion in state taxes, and 1.6 million jobs throughout the United States for a total annual economic impact of $167.0 billion."[14]

Today, due to competition from other fuels and other sources of energy, coal is used mostly to generate electricity. The coal industry will continue to meet the energy demands of the United States and the world market into the foreseeable future. In fact, we have the world's largest supply of economically recoverable coal reserves – 275 billion tons – enough to last 250 years at the present rate of consumption."[15] Coal is found in 38 states under nearly one-half million square miles – roughly 13 percent of the nation's land area (see chart below).

Figure 1. Coal-Bearing Areas of the United States



While coal provides abundant energy supplies, it also has detrimental effects on the environment, including producing acid rain and carbon dioxide emissions. Recognizing these effects, the coal industry is actively examining "clean coal" technologies and methods to capture and store carbon dioxide instead of releasing it into the atmosphere.

Solar Energy

[14] National Coal Association, Mr. Dan Gerkin, "Coal and Energy in the 21st Century", Handouts form Presentation at the West Virginia Surface Mine Drainage Task Force Symposium, 4-5 April 2000

[15] Web Site: www.unitoday.com, US Industry Today Home Page, The new coal industry, by Archive

Solar energy provides another potential resource to produce electricity in the United States. The National Renewable Energy Laboratory (NREL) stated, "PV [photovoltaic] technologies have the potential to become one of the world's most important industries."[16] "The potential PV market is enormous, ranging from consumer products (such as calculators and watches) to remote stand-alone systems for electricity and water pumping, to grid-connected systems on buildings and large-scale power plants."[17]

Some of the highly desirable characteristics of solar energy include being a secure, abundant, highly reliable domestic energy source, with zero green house emissions, and the potential for new American jobs. Both Japan and Germany have demonstrated how well designed policies and a strong government commitment can lead to the rapid adoption of PV generated energy and industry leadership. While the United States has the technological expertise and industrial base to become a major player in the global PV industry, it has not exhibited as much commitment and investment as these other countries. In order for the United States to use solar energy as an alternative to wean itself from its reliance on fossil fuels, significantly greater governmental subsidies and investments will be required.

Like other renewable energy sources, PV energy is characterized by high initial capital costs. High initial costs can make PV unattractive in the short-term, especially in competitive markets.[18] However, because PV systems tend to be durable and have few, if any moving parts, they tend to have low operations and maintenance costs. Thus, the low operations and maintenance costs make PV relatively more attractive over the long run.[19] PV systems also tend to be very simple and reliable and thus, are often well suited for remote locations ranging from third-world countries to highway call boxes.

Domestically, some analysts believe that the PV industry is likely to grow at double the growth rate of the overall economy for the next fifteen to twenty years. However, the rate of PV growth will be influenced by at least three major factors: how quickly PV production prices fall, what level of government subsidies are provided over the long-term, and what happens to the cost of energy from competing sources.

Other potential forms of solar energy explored by this seminar include the "Solar Chimney," which involves a tower nearly one kilometer high that relies on hot air rising to turn giant turbines, as well as the "Big Dish" which collects and concentrates solar energy.

Other Renewable Energy Resources

Wind, Ocean, Biomass, Geothermal, and Hydropower are additional alternative energy sources that are useful in varying degrees. However, developing and implementing these sources of energy will require significant investment and regulatory development. Even so, they represent such a small proportion of total world energy

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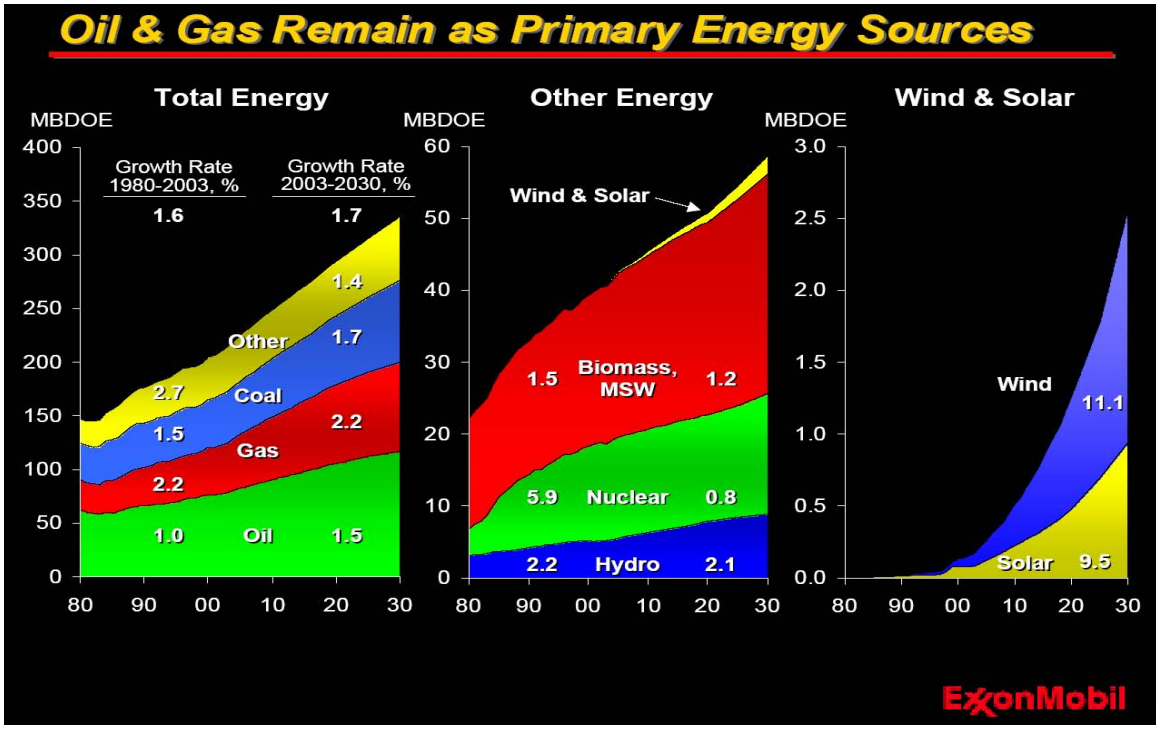
[16] Janet Sawin, "Mainstreaming Renewable Energy in the 21st Century," Worldwatch Institute, Washington DC, 2004, #169, p.22.
[17] Janet Sawin, "Mainstreaming Renewable Energy in the 21st Century," Worldwatch Institute, Washington DC, 2004, #169, p.22.
[18] Paula Berinstein, "Alternative Energy Facts, Statistics and Issues," Oryx Press, Westport CT, 2001, p.34.
[19] Department of Energy, www.eere.energy.gov/consumerinfo p.4-1. See also, Berinstein, Paula, "Alternative Energy Facts, Statistics and Issues," Oryx Press, Westport, CT, 2001, p.34.

needs, and although they are growing rapidly, they will not be enough to avert energy disasters and environmental degradation of the planet in the near future (see figure below).



Nuclear Energy

Safety, security, proliferation, and waste disposal concerns have tempered the potential growth of the nuclear power industry. Such concerns have significantly eroded public support for any growth in the nuclear power industry. Despite such concerns, "One-fifth of the nation's electricity is generated by nuclear power. Were that share substantially increased, that would reduce dependence on fuels (oil, coal, natural gas) that have large environmental and geopolitical drawbacks."[20] Future growth in nuclear energy will not occur, however, without increased U.S. government, international, and nuclear power industry efforts to complete the Yucca Mountain facility, and to develop and license new nuclear reactors to meet future safety, security, and proliferation concerns. Significant changes in U.S. and international public support would also be required before any growth in the nuclear power industry could occur.

III. Broad Energy Industry Issues

Conservation

Conservation offers significant potential to stem the growth of energy consumption and perhaps decrease the projected growth rate of U.S. foreign energy dependence. Conservation efforts offer great potential because they can be pursued without significantly constraining economic growth. Increased U.S. efficiency and

[20] George F. Will, "Nevada's Big Test," The Washington Post, March 25, 2005, p. A19.

conservation enabled the U.S. economy to grow by 126%, while energy use increased only 30%.

The Bush Administration has placed a strong emphasis on conservation in its national energy policy. "The National Energy Policy builds on our nation's successful track record and will promote further improvements in the productive and efficient use of energy."[21] The report identifies seven specific recommendations related to this goal ranging from: federal agencies conserving energy; tax credits; funding fuel cell powered transit bus programs; tax incentives; to developing clean combined heat and power technology.[22] The rapid growth of hybrid automobiles and the potential development of ultra-light materials for automobiles offer even greater conservation potential.

Pipelines

Another important part of the energy industry involves the infrastructure for the distribution of energy supplies. Pipelines are a central feature of this infrastructure. Pipeline safety and security are of critical importance to the public, both to reduce injuries and fatalities from pipeline failures and because of the importance of the products carried-natural gas, liquid products and, increasingly, hydrogen and other energy sources for the future. There are more than two million miles of pipelines in the United States.[23] Although pipeline accidents over the last several years have caused injuries and deaths around the country, since September 11th, the fear of accidents has been somewhat superseded by the fear of terrorism. In many places, pipelines carrying volatile materials are at or near the surface and these pipelines run along rights-of-way that are largely unprotected and not under constant surveillance.

In addition to injury or loss of life, the disruption of pipeline capacity in constrained markets can create energy shortages that have far-reaching economic consequences. Pipeline accidents can cause price spikes or longer-term price rises. Redundancy, storage capacity, and rapid recovery can somewhat smooth out the short-term effects; however, recovery from more widespread disruptions would be more difficult. The U.S. consumes about 19.5 million barrels per day (b/d) of petroleum products. There are approximately 200,000 miles of interstate crude oil and petroleum product pipelines in all 50 states of this country. In addition to oil pipelines, there are 180,000 miles of interstate natural gas pipelines as well. Pipelines carry about 68% of the petroleum and petroleum products and more than 90% of the natural gas products moved domestically.[24] Pipelines are an extremely efficient transportation system. As a testimony to the efficiency of the pipelines, America's oil pipelines transport 17% of all U.S. freight, but represent only 2% of the nation's entire freight bill.[25]

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[21] National Energy Policy. p. xii.
[22] National Energy Policy. pp. vii – x.
[23] Samuel G. Bonasso, Deputy Administrator, Research and Special Programs Administration, U.S. Department of Transportation, Testimony Before the Subcommittee on Highways, Transit and Pipelines, Committee on Transportation and Infrastructure, U.S. House of Representatives, Jun 16, 2004, pg. 2.
[24] Terry Boss, Vice President of Environment, Safety and Operations for the Interstate Natural Gas Association of America (INGAA), *Testimony Before the Committee on Science*, U.S. House of Representatives, Mar 13, 2002.
[25] Tim Felt, President of Explorer Pipeline, *Testimony Before the Committee on Science*, U.S. House of Representatives, Mar 13, 2002.

CHALLENGES

Among the many challenges faced by the energy industry, this seminar focused its examination on four areas: the environment, technology diffusion, diplomacy, and international development.

I. Environment

Burning fossil fuels to generate energy produces significant pollution and environmental damage whose long-term impacts are not fully clear. What was clear during our studies was that without regulation, the energy market cannot properly allocate environmental and social costs associated with energy production, distribution, and consumption. Various energy sources effect the environment in predictable ways. These effects include impacts on air quality, water pollution, land degradation, changes in ecosystems as well as global warming. The primary source of pollution from fossil fuels is carbon dioxide, nitrous oxide, sulfur dioxide, and methane. While all four are significant pollutants, carbon dioxide is the primary global warming pollutant.[26]

The coal industry best illustrates the energy-environmental relationship. First, coal-fired power plants contribute to the acid rain problem. Acid rain results when sulfur oxides from coal combustion mix with chemicals in the atmosphere to produce rainfall with increased acidity. Acid rain can cause damage to monuments and buildings, sensitive plants and wildlife, rivers and streams, and possibly human health. Second, many scientists believe that carbon dioxide produced by burning coal and other fossil fuels contributes to the greenhouse effect by trapping the sun's heat in the atmosphere and eventually causing major changes in the world's climate. Third, the coal industry faces the requirement to restore the land to its original condition. Fourth, coal-mining activities frequently consume and interfere with water resources. For example, coal extraction modifies the ground water system around a mine. While the coal industry has long been concerned with lessening its potentially harmful environmental impacts,[27] the lack of clear and quantifiable measures of those environmental impacts in the energy market makes it difficult for the industry to determine the appropriate resources to be devoted to environmental issues.

Kyoto Protocol

The Kyoto Protocol is a multinational effort to reduce greenhouse gases globally. President Clinton formally signed the Kyoto Protocol in November 1998. Other signatories to the protocol consider U.S. participation central to succeed in reducing worldwide CO_2 emissions. "The U.S. contains only 4 percent of the world's population, but emits 25% of all the world's carbon dioxide emissions."[28] However, neither President Clinton nor President Bush presented the treaty to Congress due to the Byrd-Hagel Senate Resolution (S. Res. 98). This resolution specified that the U.S. would not

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[26] Katherine Morrison, "Towards a New Energy Future: How Clean Energy Solutions Reduce Global Warming and Save Consumers Money," U.S. PIRG Education Fund. July 2004, page 2.
[27] See for example, a statement by the Hon. Lee H. Hamilton, in the House of Representatives, Wednesday, September 16, 1992. Web Site: www.thomas.loc.gov .
[28] Paul Tolme, "It's The Emissions, Stupid," National Wildlife Federation, April/May 2005, page 42.

be party to any agreement that does not require developing countries to participate or to participation in an agreement that might damage the U.S. economy.[29] Throughout this study, the seminar paid particular attention to the U.S. and Australian perspectives on the Kyoto Protocol and on international criticism of their refusals to accede to the treaty.

During this study, U.S. and Australian officials highlighted the fact is that both countries have a high GDP per capita and rely heavily on coal as an affordable energy source to provide each country with competitive advantages in the global economy. U.S. officials noted that historically, U.S. CO_2 emissions have grown at half the rate of GDP. Similarly, Australian officials argued that while Australian CO_2 emissions are the global leader per capita, the Australian population is among the smallest in the developed world.

While the seminar participants recognized both U.S. and Australian arguments against participating in the Kyoto Protocol, the study determined that both countries need to expend additional resources to reduce CO_2 emissions beyond their current voluntary goals whether or not such efforts are conducted within the confines of the protocol.

Carbon Capture and Storage: Sequestration

The seminar focused considerable attention on carbon sequestration as one of the emerging technologies designed to address the environmental concerns resulting from burning fossil fuels. Sequestration is the process of capturing, or trapping the CO_2 created by burning fossil fuels. The captured CO_2 is then stored or deposited somewhere other than the atmosphere. This strategy seems to show great promise with several nations, including the U.S., Canada, Norway, Japan and others, already putting new sequestration methods into action and studying the effects of their efforts.

Our study found that a multi-front strategy, which combines the promising solutions of conservation, alternative energy, and sequestration, is the best plan of attack to win the war on carbon. While the nations of the world are aware of the CO_2 problem, and are taking some steps in the right direction to resolve it, the biggest obstacle to their efforts is the justification of the costs involved. Fossil fuels, for all the environmental problems and concerns they cause, are still considerably less expensive on the market than any of the alternatives. However, the study participants determined that the potential effects of global warming on the world's climate, along with forecasts of sunken lands and a new Ice Age, require the advanced economies of the world to promote financing efforts to combat these dangers.

II. Technology Diffusion

Another key challenge for the energy industry is moving new technologies and innovations from development to the market. Diffusion of technology in the energy industry is an international concern as a vital component of sustainable development. The report of the 2002 World Summit on Sustainable Development defined diffusion as a way to describe the "demand-pull" concept of how technologies should flow.[30] In diffusion, free market forces pull technologies from the places they are created to the places where their application would have the highest value.

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[29] "U.S. Emissions of Greenhouse Gases in Perspective," report #: EIA/DOE 0573 (98), November 5, 1999, pp 9-10. http://www.eia.doe.gov/oiaf/1605/gg99rpt/emission.html. Downloaded on March 22, 2005.
[30] E7. Renewable Energy Technology Diffusion. May 2003. p.4.

Public policies provide a "level playing field" to encourage diffusion.[31] The diffusion process is complex - many external factors such as legal and political barriers, financial backing, cultural disruptions and environmental considerations can impede the process. In some cases, it takes years, even decades for a technology to be commercialized.

The Organization for Economic Cooperation and Development (OECD) believes that the proper conditions must be in place to encourage technology diffusion, including:

- Stable economic, financial and tax systems for investing partners
- A Transparent legal and regulatory structure and sound foreign ownership regulations
- Flexible and sound labor rules for workers
- Protection of intellectual property rights and sound environmental laws and standards, all based on scientific assessment
- Free capital flows and stable rules for foreign currency exchange and well-functioning administrative structures
- A stable regulatory framework fostering innovation in a cost-effective manner
- The absence of excessive bureaucratic rules and delays
- Regular and open communication between government and industry.[32]

The biggest challenge will be to identify the best path for commercial ventures that will propel the initial adoption, and ultimately, the diffusion of the technology. This is especially true in the area of fuel cell research.[33]

Foreign direct investment by multinational firms is the leading channel for technology diffusion today, but another important channel is through collaborative research and development (R&D), as well as professional exchanges. A wide number of government initiatives, from subsidizing R&D to voluntary agreements, standards, tax breaks and 'cap and trade systems,' can assist with technology diffusion. Another way the government can support technology diffusion is through licensing agreements that protect industry.

The current National Energy Policy (often referred to as the Cheney Plan) provides important incentives to promote technology diffusion, such as a proposed $2 billion for research on clean coal technologies. Other incentives by the federal government include tax credits and subsidies for efficiency improvements such as hybrid cars and solar energy, and outright federal purchases of renewable energy, efficient vehicles, and advanced conversion technologies for federal use. Federal, state, and local governments are also in a unique position to foster education and information programs that encourage energy efficiency and greater use of renewable energy.

III. Diplomatic

The U.S. also faces significant diplomatic challenges to pursuing its energy policies. In addition to the issues involved with the Kyoto Protocol, U.S. foreign oil

[31] E7. Renewable Energy Technology Diffusion. May 2003. p.4.
[32] E7, Renewable Energy Technology Diffusion, May 2003, p.4.
[33] E7, Renewable Energy Technology Diffusion, May 2003, p.8

dependence requires the U.S. to build strong relationships with energy-producing countries, improve the outlook for trade and investment, and to develop reliable supplies and information. The U.S. also must support American energy firms competing in markets abroad through membership in multilateral organizations, such as the OECD, the Asia-Pacific Economic Cooperation (APEC) forum, the World Trade Organization (WTO) Energy Services Negotiations, and the Free Trade Area of the Americas (FTAA). The U.S. goal is to promote and implement a system of clear, open, and transparent rules and procedures governing foreign investment in the energy sector. Through bilateral commercial policy forums,[34] and through leadership and participation in multilateral organizations,[35] the Federal agencies are working to create a level and transparent playing field for U.S. companies[36]overseas and reduce barriers to trade and investment as a strategic means of achieving our economic, environmental, and other national objectives. For example, DOE and USAID have provided grants for Clean Cities Coalitions and training programs in New Delhi, India; Dhaka, Bangladesh; cities in the Philippines; Mexico City, Mexico; and Lima, Peru, to assist with the conversion of vehicles to cleaner fuels. The Administration led the 2003 formation of the International Partnership for the Hydrogen Economy (IPHE) to coordinate and leverage multinational hydrogen research programs. IPHE will address the technological, financial, and institutional barriers to the hydrogen economy and develop internationally recognized technology standards to speed market penetration of new technologies.

The U.S. also promotes a coordinated approach to energy security by calling for an annual meeting of G-8 Ministers or their equivalents.[37] The U.S. needs to continue its relationships with other countries and institutions to expand the resources and types of global energy supplies. The U.S. also needs to enhance its economic security goals by increasing the efficiency of energy consumption, enhancing transparency, and by efficient operation of energy markets, strengthening capacity to respond to the disruptions of energy supplies, and at the same time achieving goals of environmental protection. Finally, the U.S. needs to strengthen its trade alliances to deepen its dialogue with major

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[34] FORA Participations: U.S.-China Oil and Gas Industry Forum, U.S.-Russia Commercial Energy Summits, North American Energy Working Group, the International Partnership for the Hydrogen Economy, the Carbon Sequestration Leadership Forum, the U.S.-Russia Commercial Energy Dialogue, the U.S.-Russia Energy Working Group, and the U.S.-African Energy Ministerial process. Source: National Energy Policy, March 2002.

[35] Multilateral Organizations: Asia-Pacific Economic Cooperation (APEC) forum, the Organization for Economic Cooperation and Development (OECD), the World Trade Organization (WTO) Energy Services Negotiations, the Free Trade Area of the Americas (FTAA). Source: National Energy Policy, March 2002.

[36] Examples: promoting best practices for LNG trade and financing of cleaner and more efficient energy among APEC members. APEC Annual Report, January 2005.

[37] Some of the G-8 efforts were: 1**)** Energy Ministers in May 2002, resulting in the issuance of a Joint Statement committing to cooperation in energy security, emergency responses, energy dialogue among producers and consumers, research, development and deployment and fostering open markets and a favorable/stable investment climate; 2) an informal meeting of G-8 energy ministers hosted by France in April 2003 which continued the dialogue on oil markets, producer/consumer relations, Iraqi production and market transparency; 3) G-8 Summit in Evian, France in 2003, a science and technology action plan was endorsed which included cooperation in CSLF and IPHE; and 4) the G-8 Summit in June 2004 called for continued G-8 action to implement the Evian Action Plan and achieve concrete results. Source: National Energy Policy, Status Report on Implementation of NEP Recommendations, January 2005.

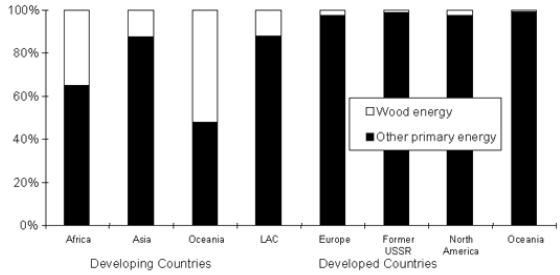
energy resource producers and suppliers all over the world in order to promote growth in other areas of economy such as transportation and the environment.

IV. Development

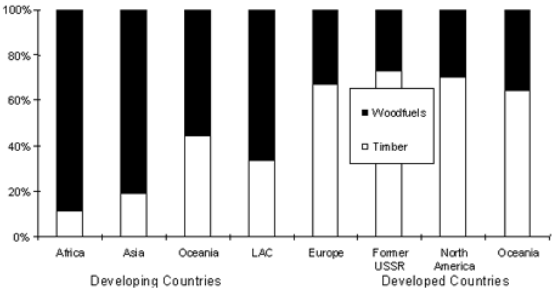
The access to energy, in terms of quantity of supply and price, is a serious concern for developed countries, which all try to optimize their strategies and policies, looking at the short, medium, and long terms. When it comes to developing countries, energy is even more crucial, because it is an absolute necessity to increase their welfare but also because it is, for many people on earth, still a matter of survival. The world is decidedly a contrasted place, where basic resources for half the human beings are not available for the other half. Today, an estimated 2 billion people[38] on earth do not have adequate energy services (neither affordable nor reliable energy supplies). For the most part, these 2 billion people are living in rural areas of developing countries with access only to traditional fuels, like wood or crop residue. The lack of energy services is still clearly correlated with most poverty indicators: there is no example of sustainable modern development without reliable access to some form of energy. The main energy issues of the rural population in developing countries are consequences of the use of wood, animal waste, and crop residue as fuels - the overuse of wood-fuel has detrimental impacts on the environment in those areas,[39] the smoke of burning wood and crop residue

[38] Executive summary of "The Challenge of Rural Energy Poverty in Developing Countries," World Energy Council, http://www.worldenergy.org/wecgeis/publications/reports/rural/exec_summary/exec_summary.asp

[39] "Wood energy situation and trends", World Energy Council, http://www.worldenergy.org/wecgeis/publications/reports/rural/wood_energy_situation/annI_3_2.asp



Wood-fuel in primary energy supply, in percentage, source FAO et United Nations - 1995



Wood-fuel versus timber consumption, source FAO - 1997

seriously affects the health of these populations, especially women and children who are already the most impacted by the burden of collecting the raw material.[40]

Local governments or international agencies take several kinds of actions, in order to improve the situation in rural areas, for example by providing improved cooking stoves. The World Health Organization reports that indoor pollution is the fourth largest health risk in developing countries.[41] Other programs include rural electrification,[42] and help in "forest management" in order to avoid the on-going process of "forest shrinking" (one of the objectives of the "Millennium Development Goals"[43]). As demonstrated in a recent study, if correctly managed, wood-fuels "could contribute to moderating greenhouse gas emissions and also developing sustainable forest management systems."[44]

Rather different energy issues exist in urban areas of developing countries, such as low level of efficiency in energy use. This is true especially in transportation, where it is common to observe poor, inefficient engines. Pollution, especially of air and water, is directly linked to energy production and supply. Taking care of polluting gas emissions and washing coal, for example, are procedures that are too expensive for developing countries. Urban areas also have insufficient access to energy in many areas of big cities, especially in slums. 25-50% of urban residents in developing countries are living in slums, most often with no access to legal electricity.[45]

Several independent studies indicate that "an amount of energy roughly equivalent to 7% of the world's electricity production today could cover basic human needs."[46] This seems easy as an equation but it is a hard challenge on the field. The importance of energy for development is so clear that many international organizations and agencies now have a specialized and dedicated department for energy issues.

The developing world also includes countries rich in resources, but still struggling to develop a rich, diverse economy. Oil resources form the basis of the economic systems of a number of countries, including Saudi Arabia, Nigeria, and the United Arab Emirates (UAE). These rentier states, states whose economies are largely dependent upon a single resource, depend upon oil as a primary and even dominant source of revenue and economic diversification. Excessive reliance on oil as the driving force behind a national economy may offer short-term benefits, but economic diversification and development of other economic sectors offers the best strategy for long-term growth.

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[40] See EU Energy Initiative (EUEI), "Why an Energy Initiative?", http://europa.eu.int/comm/development/body/theme/energy/initiative/why_en.htm.
[41] World Health Organization, *The world health report 2002*, http://www.who.int/indoorair/en/.
[42] Executive summary of "The Challenge of Rural Energy Poverty in Developing Countries", World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/rural/exec_summary/exec_summary.asp
[43] Millennium Development Goals, Environment, Target 9, "Forests Shrinking", http://www.developmentgoals.org/Environment.htm#target9
[44] "Wood energy situation and trends", World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/rural/wood_energy_situation/annI_3_2.asp
[45] idem
[46] Executive summary of "The Challenge of Rural Energy Poverty in Developing Countries", World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/rural/exec_summary/exec_summary.asp.

As Albert Hourani suggests, wealth generated by oil is both a strength and a weakness.[47] As a strength, oil revenues permitted countries such as Saudi Arabia, and the UAE to create various economic development initiatives and to build hospitals, universities and lower schools, provide for social welfare payments, and support agriculture. Oil revenues also made it possible for producing nations to purchase from more advanced industrial nations those goods and services that they themselves either did not produce or did not wish to produce. Consequently, according to Hourani, dependence on oil revenues inhibited certain types of economic development, which ultimately ensured that the oil-producing nations would lag behind industrialized, technologically oriented nations in many key sectors.[48]

[47] Albert Hourani, "A History of the Arab Peoples," Cambridge: Harvard University Press, 1991, pp 408 – 409.

[48] Albert Hourani, "A History of the Arab Peoples," Cambridge: Harvard University Press, 1991, pp 408 – 409.

OUTLOOK

Based on currently viable technologies, U.S. dependence on oil, particularly in the transportation sector, will likely continue to grow at least for the next ten to twenty years. This industry study determined that significant improvements may be made to slow this rate of growth through aggressive conservation measures over this time period. In the long-term, however, the seminar participants concluded that U.S. national security interests to reduce U.S. dependence on foreign energy supplies will require significant governmental investment to develop alternative sources of energy. Further, the seminar believes that such measures to spur development are more likely to be successful if they are developed to supplement the energy market in the form of economic incentives and market-conscious regulations.

With a 250- to 300-year supply of coal in the U.S., the picture of coal's role in the future is bright. However, coal has to overcome its significant environmental drawbacks. Modern coal combustion facilities, such as those found at many of the nation's electric power plants, use equipment to remove most of the polluting elements from coal smoke. "Coal is the answer to our energy independence challenge long into the foreseeable future. Because coal is abundant, low-cost and reliable, coal will continue to be the dominant fuel source for the United States and world power generation. The federal government and the coal industry must work hand-in-hand to overcome the challenges of the environmental, labor and financing capacity issues. Sound energy policies and supporting legislation will be required to meet these challenges while providing the required degree of certainty to allow strategic investments by both the power generation and coal mining industries."[49]

The outlook for nuclear energy, on the other hand, remains uncertain. Major concerns regarding the safety, security, proliferation, and long-term storage of nuclear waste have prevented the expansion of nuclear energy whose low environmental emissions would otherwise serve to encourage the growth of nuclear energy. During the course of this study, the participants learned that a new application for a new nuclear energy plant permit for the Calvert Cliffs, MD nuclear facility was submitted.[50] This is the first such application submitted in past 30 years. The success or failure of this application in gaining approval for a new nuclear power plant will determine whether further growth in this sector of the industry is possible.

The U.S. electricity grid and pipeline infrastructure suffer from lack of investment. Despite many similarities to the U.S., Australia has not experienced problems such as the energy market collapse in California nor the electricity blackouts such as occurred in the eastern U.S. in August 2003. While Australian investment in its infrastructure also needs improvement, the Australian regulatory agencies have approved many of the critical investments proposed by its energy companies. In the U.S., the combination of tight regulation, privatization in a tight, competitive market, along with strong short-term political pressures to keep prices down, has vastly increased energy

[49] Alliance Resource Partners, L.P., Coal 2020 – Burning Questions Conference, Where will the coal come from? Key challenges for the Coal Industry between now and 2020, October 12, 2004

[50] Paley, Amit R., "Calvert Cliffs Site Pushed for New Nuclear Reactor," The Washington Post, May 21, 2005, p. B1.

efficiency and kept prices low. Long-term investments and infrastructure improvements, however, have not materialized. Such investments remain urgently needed.

Environmental and social challenges posed by energy are more likely to increase than decrease over the coming years. On their own, free and open markets will not be able to address such challenges except in conjunction with appropriate U.S. governmental mechanisms to account for the true environmental and social costs imposed by specific energy resources and to encourage conservation and development of alternative energy resources.

GOVERNMENT ROLE

The proper role of government in the energy industry was a common and frequent theme during this study. This study determined, however, that governmental intervention into the energy market should be conducted carefully and only applied for certain, specific purposes when the market has proved to be insufficient to address specific challenges. The role of government, therefore, should be to supplement the market by providing greater information to the market, by developing mechanisms to allocate costs for environmental and social challenges, by providing energy security, and to spur investment to meet long-term U.S. energy interests.

The Bush Administration has developed, defined, and published its National Energy Policy. One of the goals of the National Energy Policy is to expand supply from diverse sources. The report identifies the fact that 90% of new U.S power plants use natural gas, thus driving the need to diversify fuel sources to reduce vulnerabilities to price spikes. Additionally, the U.S. needs to leverage its abundant coal reserves by researching clean coal technologies and expand the use of nuclear energy. The report states, "Our policy will increase and diversify our nation's sources of traditional and alternative fuels in order to furnish families and businesses with reliable and affordable energy, to enhance national security, and to improve the environment."[51] The report identifies 7 recommendations related to the goal of increasing energy supplies, ranging from: opening the Arctic National Wildlife Refuge (ANWR) to environmentally regulated exploration and production; earmarking $1.2B of ANWR bid bonuses to fund research of alternative and renewable energy resources; enacting legislation to expand alternative fuels tax incentives; providing $2B over 10 years for clean coal technology research; to establishing a national repository for nuclear waste, and streamlining the licensing of nuclear power plants.[52]

However, the National Energy Policy does not do enough to address the growth of imported petroleum, which the transportation sector relies on as its primary fuel. For example, the policy fails to address the need to increase the fuel efficiency of our vehicles. Additionally, while the policy identifies environmental issues and focuses efforts to make improvements, the policy falls short.

The U.S. has an opportunity and a responsibility to set the standard for countries around the world. While acknowledging the need to take a gradual approach and minimize economic disruptions, the policy fails to take appropriate environmental actions such as addressing CO_2 issues. Another report by The National Commission on Energy

[51] National Energy Policy, p. xiv.
[52] National Energy Policy, pp. xiii-xiv.

Policy merits serious consideration. This bipartisan report offers a more balanced approach, including specific regulatory recommendations forcing industry to take actions, rather than waiting for the market to drive the changes.

Regarding the prospects for biodiesel, Federal biodiesel supply incentives should be revised to provide a clear competitive advantage to biodiesel over petroleum-based diesels at the point of sale, regardless of the feedstock used for production. This will allow the U.S. biodiesel industry to use market forces to develop in the most efficient manner, while overcoming the competitive advantage the petroleum-based diesel industry enjoys from decades of market subsidies.

One governmental action studied during this seminar proposed a "carbon tax" be applied to a fuel source based on the amount of CO_2 the fuel emits. This proposal provided for revenues from this tax be used to reduce the nation's deficit and ignite investment in research and transition to environmentally friendly energy sources.[53] The U.S. needs incentives such as tax credits or expensing of capitol costs (faster depreciation so costs are recovered more quickly) to convert to higher energy efficient modifications or construction of energy efficient structures.[54] Finally, research shows that consumers want to purchase environmentally sound energy sources, but they lack the information to use when making their decisions.[55] If energy suppliers provided consumers with a full disclosure of the environmental impacts of an energy source, the educated public might demand green energy sources, which would ultimately ignite economic forces to answer this demand with appropriate "supply." Another potential governmental proposal suggests that the President require the electric power industry to adopt a "Renewable Portfolio Standard" (RPS), which requires the utilities to certify that a portion of their power generation was from renewable sources in small increments until reaching a target of 10% by the year 2020.[56]

Federal intervention into the market, when necessary, must be carefully crafted using voluntary targets, regulation, renewable energy certificates, market pricing of emissions, investments, R&D, price controls, and foreign policy tools. While the Kyoto scheme does not adequately address issues associated with externalities such as climate change in developed countries such as the U.S. and Australia. Specific tools and measures should be developed and integrated to provide incentives to reduce CO_2 emissions while recognizing that affordable energy is a competitive advantage in the international economy.

Investment is the key to invigorating the energy market. The federal government can play a key role in channeling investment into the right sectors for maximum potential output and to provide a direction for private investment.

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[53] Burtraw, Dallas, and Portney Paul, R. "A Carbon Tax to Reduce the Deficit". New Approaches on Energy and the Environment: Policy Advice for the President. Resources for the Future. 2004. Page 19.
[54] Bamberger, Robert L. and Behrens, Carl E. Energy Policy: Legislative Proposals in the 109th Congress. Resources, Science, and Industry Division. Congressional Research Service. Library of Congress. CRS Issue Brief for Congress, Order Code IB10143. Updated January 21, 2005. Page 9.
[55] Lashof, Daniel, Silva, Patricia, et al. "A Responsible Energy Policy for the 21st Century," Natural Resources Defense Council. March 2001, Page 24.
[56] Darmstadter, Joel. "Stimulating Renewable Energy. A "Green Power" Initiative," New Approaches on Energy and the Environment: Policy Advice for the President. Resources for the Future, 2004, page 28.

ESSAYS ON MAJOR ISSUES

The energy industry study team identified several major themes that emerged during its studies. First, the Australian energy sector provided an interesting case study. Second, the continued importance of coal to the long term energy needs of the U.S. and the world was evident. Finally, environmental concerns and the importance of developing renewable energy resources was highlighted throughout this study.

ESSAY 1
AUSTRALIAN ENERGY: ABUNDANT RESOURCES AND SCARCE POLICY
AUTHOR: Mike Hutchison

National power is usually measured in terms of military power, economic vitality, and abundance of natural resources. Chief among the natural resources that can contribute to national power is energy supplies. Australia is a nation with abundant reserves of various fossil fuels and other energy sources. The country uses its energy resources primarily for its own consumption, and as valuable commodities that it trades on national and world energy markets. Australia has undertaken significant measures to reform some of its internal energy markets. In addition, the Government of Australia has adopted controversial policies on the environment and energy use and development. Whether these policies are effective in controlling the environmental impact of fossil fuels, and ensuring the country's energy security in the coming years is open to question.

Australia's Energy Resources

Australia is an energy-rich country, with large reserves of petroleum, coal and natural gas. In fact, the energy resources of Australia are so large that the country is a significant net exporter of certain energy commodities, such as coal, liquefied natural gas (LNG), and uranium.[57] However, declining levels of oil production coupled with large increases in demand have led in recent years to Australia becoming dependent on imports of petroleum.

Coal is abundant in Australia. The country's coal reserves are currently estimated at approximately 90.5 billion short tons (Bst), and are about evenly split between black coal and brown coal (lignite). Based on 2002/2003 data, Australia is the fourth largest producer of coal, mining over 378 million short tons (Mmst). During the same period, the country consumed approximately 160 Mmst of coal. The remainder, approximately 60%, of its annual production is exported, accounting for 28% of world coal exports, making it the largest exporter of coal.[58]

Natural gas reserves in Australia are significant and, at 90 trillion cubic feet (Tcf), are the largest in the region. Most of these reserves are located offshore, with only 10% located inland. With the growth in discoveries of new reserves has come a growth in production capacity. Natural gas production grew from 690Bcf in 1995 to 1.26 Tcf in 2002, with further growth expected.[59] Australia only uses about 17% of the natural gas it

[57] Energy in Australia – 2004, September 2004, Australian Bureau of Agriculture and Resource Economics, 14 March 2005.
[58] Country Analysis Brief – Australia, November 2004, U.S. Department of Energy, 14 March 2005.
[59] Ibid.

produces and exports the rest in the form of liquefied natural gas (LNG). In 2002, Australia provided 7% of the world LNG exports, making it the sixth largest exporter of LNG.

As with its natural gas reserves, most of Australia's oil reserves are located offshore. As of 2004, the country estimated it had approximately 3.5 billion barrels of oil reserves. Production of oil in Australia peaked in 2000 at 805,000 barrels/day, and decreased to 630,000 barrels/day in 2003. Production is projected to decline further reaching only 560,000 barrels/day in 2006.[60] At current consumption levels, Australia is self-sufficient for 77% of its oil needs.[61]

Australia has the world's largest reserves of uranium, currently estimated at 702,000 tons. With only three mines currently operating, the country manages to produce 9500 tons of uranium oxide per year.[62] Despite Australia's richness in uranium, Australia consumes no energy generated by nuclear power. Instead, the country exports all of its uranium production, mostly to the U.S., Japan, Korea, and the European Union, and strictly for peaceful uses.

Despite being a sunny, windy island-continent on the edge of the geologically active Pacific rim, Australia obtains relatively little of its energy needs from renewable energy sources such as wind, solar or geothermal. In 2002, Australia obtained less than 5% of its energy needs from renewable sources, including wood, bagasse, solar and hydropower. However, generation of electricity from renewable sources is projected to increase by about 2.6% per year until 2020. Most of the projected increase is derived from wind power.

Reform of the Energy Markets

The Australian Federal Government initiated reform of the electric industry in the early 1992 by breaking apart the state-owned utilities into separate electricity generation, transmission, distribution and retail supply 'entities.' Many of these entities were then either privatized, or managed by private companies under long-term contracts with the Government. Some still remain under Government ownership. In separating the state-owned utilities into functional components, the Government horizontally separated the electric power generation component into multiple competing businesses. In addition, each of the Australian states, such as New South Wales, Victoria, and Queensland are pursuing separate energy strategies. New South Wales, for example, continues to own energy production companies while the others have emphasized privatization of state companies.

So far, whether one views electricity market reforms as successful depends on where one sits. Reform has brought huge increases in labor productivity, with the number of employees employed in the power industry being cut almost in half since 1990. For the consumer, electric prices are down overall by about 10% in real terms since 1990.[63] Although, Southern Australia reports higher retail prices after competition

[60] Ibid.
[61] Marie Taylor, Australia's Approach To Managing An Oil Emergency, 7 April 2004, Australian Department of Industry, Tourism and Resources, 2 March 2005.
[62] Australia's Uranium And Who Buys It, February 2005, Uranium Information Centre, 15 March 2005.
[63] IEA Approves Australia's Energy Liberalization, Adds That Reforms Must Respect The Environment. 9 July 2001, International Energy Agency, 18 February 2005.

was introduced in January 2003. In addition, some volatility in price has been encountered and there have been several instances of supply failures in the past several years.

Environmental Concerns

Reforms to the markets for some of Australia's abundant energy resources have not altered the impact of Australia's prodigious energy use on the environment. Australia's heavy dependence on the automobile for transportation and coal plants for power generation contributes to significant ozone and particulate pollution. However, it is greenhouse gases that are the primary cause for concern with regard to Australian pollution. According to the Intergovernmental Panel on Climate Change, Australia's net greenhouse emissions for 2001 were 542.6 million tons of carbon dioxide equivalents.[64] With a population of slightly less than 20 million, Australia thus has the highest per capita emissions of greenhouse gases in the world.

The Kyoto Protocol calls for Australia to reduce (or, more appropriately, control) its greenhouse gas emissions by the 2008 – 2012 timeframe to 108% of 1990's level. However, the Australian Government has decided to join the United States in its 'coalition of the willing' on Kyoto and refuses to sign the Kyoto Protocol. Instead, the Australian has committed itself to voluntarily meeting the Protocol's limits. Current estimates place Australia's greenhouse gas emissions in 2010 to be between 110 and 123% of 1990 levels.

In general, the Government looks to control pollution by raising fuel efficiency standards for cars, and establishing a target of 10% for electricity generated by renewable fuels. The Government also believes that reforming energy markets will drive power producers to natural gas, thereby reducing Australia's consumption of coal. But, the current Prime Minister's bottom-line stated policy is that the Government will adopt only those policies that are cost-effective, minimize burden on business, and maintain Australian commercial competitiveness.

Energy Policy

In 2004, the Australian Prime Minister, John Howard, released an energy White Paper entitled "Securing Australia's Energy Future." The paper is a strategy document which covers the period out to 2020 and outlines the Government's approach to ensuring Australia has access to energy, maximizes the value of its energy resources, and "manages" environmental issues. In its 191 pages, the paper outlines a number of energy-related policies, many of which are restatements of prior Government policies or initiatives. Some of the policies are new.

The major component of the White Paper is reform of the fuel excise system. Australia collects about $13 billion in excise. This figure constitutes 7% of total Government revenue. The point of the reform is to remove more than $1.5 billion in excise taxes from business and households. By 2013 when the reforms are completely phased-in, excise will only be paid on fuel used by on-road business vehicles with a gross weight of less than 4.5 tons, and private use vehicles. No excise will be paid on fuel used for power generation or home heating.

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[64] Dwyer, Mark; Power, Tim; Taberner, John; van Merwyk, Tony; and Back, Michael, Renewable Energy & Greenhouse Update (Australia), 20 October 2003, Mondaq Business Briefing, 10 February 2005.

Another major announcement in the Paper was $75 million in Government support for an initiative called Solar Cities. This initiative is essentially a Government-supported 5-year trial to determine if distributed solar collectors can provide cost-effective power into the grid while still supplying the power needs of the distributed location. Other initiatives in the White Paper include: reiteration of support for the Mandatory Renewable Energy Target (MRET) of 10% for the generation of electricity by renewable energy sources by 2010; tax incentives for offshore oil exploration; $100 million in undefined incentives for development of renewable energy sources; and $34 million to address barriers to increased renewable energy use, such as better wind forecasting and development of wind storage technologies.

There is much to criticize in the White Paper. The Paper provided no support for emissions trading, whereby Australia could buy greenhouse gas emission credits from nations that exceed their Kyoto-established greenhouse gas emissions target. The amount of Government funding provided to alternative and renewable energy sources is paltry. More importantly, the details in the Paper on Government funding for alternative and renewable energy development allows Government funds to be used to develop technologies centered around reducing demand for and emissions from existing energy sources, as opposed to being used exclusively for new energy sources. Finally, many of the announced "new" initiatives are not new, such as energy market reform, which has been ongoing since the early 1990s.

Conclusion

Australia is blessed with abundant reserves of various forms of energy. However, the country is beginning to realize that its current energy resources won't last forever and their use has a significant environmental impact. On environmental issues such as global warming, the Government of Australia has decided to take a controversial approach by not signing the Kyoto Protocol. With regard to energy use and development, the Government issued a White Paper on Australia's energy security that emphasizes continued reliance on and development of fossil fuels. It remains to be seen whether these steps will result in an energy independent Australia that controls its impact on the environment.

ESSAY 2
AMERICA - "THE SAUDI ARABIA OF COAL"

AUTHORS: COL Steve Reviere and CDR Andreas Leinz

On March 22, 2002 in Monterey, Mexico, President George W. Bush outlined the National Security Strategy for the United States of America. In his address, the President highlighted U.S. energy concerns when he went on to state, "we will strengthen our own energy security and the shared prosperity of the global economy by working with our allies, trading partners, and energy producers to expand the sources and types of global energy supplies…[and] also continue to work with our partners to develop cleaner and more energy efficient technologies."[65]

Due to the abundance and low cost of coal as a source of electric energy, the U.S. coal industry has provided the fuel for U.S. economic prosperity throughout its history,

[65] United States of America, National Security Strategy, Section VI., page 17

and will continue to meet the energy demands of the U.S. and the world market into the foreseeable future. **"**The U.S. is recognized as the Saudi Arabia of coal. Coal is found in 38 states under nearly one-half million square miles – roughly 13 percent of the nation's land area. In fact, we have the world's largest supply of economically recoverable coal reserves – 275 billion tons – enough to last 250 years at the present rate of consumption."[66]

U.S. coal production has reached record levels, reflecting shifts in its use over the years. Large amounts of coal were once consumed for domestic heating, railroad fuel and stationery steam engines. Today, due largely to competition from other fuel sources and other sources of energy, coal is used primarily to generate electricity. "The coal industry has become the Nation's largest energy-producing industry, representing nearly one-third of U.S. energy production. Coal also accounts for almost one-fourth of total energy consumed and is the only energy source for which U.S. exports are greater than imports. The coal industry is the Nation's leading mining industry, based on value of production."[67] "From an economic direct and indirect impact, coal contributes $93.4 billion in business income, $46.5 billion in wages, $18.3 billion in federal taxes, $9.0 billion in state taxes, and 1.6 million jobs throughout the United States for a total annual economic impact of $167.0 billion."[68]

With a 250- to 300-year supply of coal in the U.S., the potential for coal is significant. However, coal has significant environmental drawbacks to overcome. The primary disadvantage of coal is the potentially damaging effect its recovery and use can have on the environment. As a result, there are several complex challenges facing the industry and its continued growth. First, coal-fired power plants contribute to the acid rain problem. Second, the coal industry faces the requirement to restore the land to a condition matching its original use before coal was mined. Third, coal mining activities frequently come into contact with water resources. Finally, many scientists believe that carbon dioxide produced by burning coal and other fossil fuels contributes to the greenhouse effect by trapping the sun's heat in the atmosphere and eventually causing major changes in the world's climate.

The good news is that modern coal combustion facilities, such as those found at many of the nation's electric power plants, use equipment to remove most of the polluting elements. In fact, so much is removed that one can hardly see any smoke at all coming from these "smokestacks." Most of what shows is steam. The dark, sooty material called fly ash that once went up the stack is now removed by filters or by devices called precipitators. This method eliminates 99.5 percent of the offending material. Coal contains sulfur, which combines with oxygen when the coal is burned to produce sulfur oxides. Beginning in the 1970s, coal producers and major coal consumer initiated a number of efforts to reduce the amount of sulfur compounds emitted into the environment. Concern over environmental quality has led to greater use of low sulfur coal in power plants.[69] Less than two decades after the Clean Air Act was passed, the

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[66] Web Site: www.unitoday.com, US Industry Today Home Page, The new coal industry, by Archive
[67] Web Site: www.eia.doe.gov, Energy Information Administration/Coal Data: A Reference, United States Coal: An Overview. p. 3.
[68] National Coal Association, Mr. Dan Gerkin, "Coal and Energy in the 21st Century", Handouts form Presentation at the West Virginia Surface Mine Drainage Task Force Symposium, 4-5 April 2000.
[69] Web Site: www.bydesign.com, fossil fuels, 1000 annotated links, History of Coal Use.

sulfur content of coal purchased and burned by electric utilities had decreased 37 percent. Physically washing coal after it is mined and before it is burned is another way to reduce sulfur compound emissions. All these techniques represent a significant investment in maintaining clean air. Electric utilities have already spent $60 billion to control sulfur emissions, and the investment has paid off.

One of the greatest current environmental concerns associated with coal is the emission of carbon. As a fossil fuel, coal also contains carbon, which combines with oxygen to form carbon dioxide (CO_2) during the combustion process. CO_2 is one of five major "greenhouse" gases, which help trap radiated heat back to the earth's surface. This "greenhouse effect" is a natural process, which maintains the earth's temperature at a level sufficient to support life. However, recent scientific and political debate has intensified over the extent to which human activity -- such as fossil fuel use and deforestation -- has caused an acceleration of the natural greenhouse effect.

A strategy for resolving this issue is carbon sequestration. Sequestration is the process of capturing, or trapping the CO_2 that is created when burning fossil fuels. The captured CO_2 is then stored or deposited somewhere other than the atmosphere. This strategy seems to show great promise with several nations, including the U.S., Canada, Norway, Japan and others, already putting new sequestration methods into action and studying the effects of their efforts.

There are several storage locations or techniques which are being developed. For years petroleum companies have been using CO_2 gases to recover the remaining oil in nearly depleted reservoirs, through a process called enhanced oil recovery. This process provides a technique for sequestration by injecting the gas underground into oil reservoirs. The strategy here would be to inject large quantities of captured CO_2 into these depleted reservoirs for long term storage. Additional destinations of underground injections of CO_2 include depositing it into deep saline formations, unmineable coal seams and depleted gas wells. All of these destinations would provide ample space for the large amounts of CO_2 which would be captured. Many such sequestration projects are underway as well as ongoing studies at these locations to determine whether the CO_2 will indeed “stay put” in these areas and what the effect(s) would be on the environment should one of these deposit sites allow CO_2 “leakage” to the surface or the immediate area surrounding the deposit location.

Another experimental storage location is deep in the world’s oceans. The oceans have been absorbing CO_2 naturally from the atmosphere for as long as the gas has existed. New technology has been developed which allows for the trapping of CO_2 gases, liquefying them and then injecting them into the ocean at great depths to be absorbed. Experiments have shown that when the CO_2 is introduced to the water it takes on the form a giant “blob.” Studies are in progress on the effects of this carbon “blob” on the ocean’s marine life, how long it will take to be absorbed, and whether it will stay at depth or rise to the surface, and the consequences of such an event occurring. Should the results prove this technique to be a viable option, the oceans would provide the single largest depository for the trapped CO_2 and likely become the primary storage location. Given coal's vital present and future role in meeting the world's energy needs, solutions to concerns over possible climate change will have to be global in nature and carefully

balance environmental objectives with viable options for continuing to fully utilize fossil fuels."[70]

The federal government and the coal industry must work hand-in-hand to overcome the challenges of environmental issues. Sound energy policies and supporting legislation will be required to meet these challenges."[71] As a major world producer, the U.S. must act responsibly now to develop clean coal technologies, promote global standards, and look for more environmentally friendly ways to extract and use this abundant energy source. As the President stated in the U.S. National Security Strategy, "we must develop cleaner and more energy efficient technologies."[72] In the near term and beyond, coal provides the U.S. with an abundant energy resource that could provide for a significant portion of U.S. energy needs if clean coal technologies and/or carbon sequestration can be developed economically.

ESSAY 3
RENEWABLE ENERGY IS GREEN ENERGY

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After costs, the environmental impact of energy extraction, production and consumption on local and global environments is among the most important areas of debate today. The worldwide reliance on fossil fuels has caused significant environmental damage in most areas of the world; increasing chronic respiratory illnesses, polluting waterways, poisoning crops and killing forests. Current atmospheric research is showing that increased emissions of carbon dioxide are increasing ambient temperatures worldwide and causing global climate change with uncertain consequences. At the same time, the demand for energy in the industrialized and emerging economies is growing on pace with economic development. This conflict between energy and the environment is often described as an either or choice during policy development. This is disingenuous, as there are ways to move from a fossil fuel energy portfolio towards a greener, renewable energy portfolio while maintaining economic growth.

When viewed thru an environmental focus, energy sources can be divided into one of two categories; those derived from fossil fuels such as coal, natural gas and oil and those from renewable sources such as wind, solar, geothermal, hydroelectric, nuclear and bio-fuels. Each of these categories, have potential damaging environmental affects. The key challenge for policy makers is to maximize energy availability, while minimizing environmental degradation.

Fossil Fuels

Oil, gas and coal extraction causes significant water pollution; fouling mountain streams with acid mine drainage and mining overburden; contaminating groundwater

[70] Web Site: *www.ket.org/Trips/Coal/AGSMM/agsmmfuture.htm.* What is Coal's Future?, COAL: Ancient Gift Serving Modern Man, American Coal Foundation.
[71] Alliance Resource Partners, L.P., "Coal 2020 – Burning Questions Conference, Where will the coal come from? Key challenges for the Coal Industry between now and 2020," October 12, 2004.
[72] United States of America, National Security Strategy, Section VI., page 17.

from drilling mud disposal and polluting beaches and estuaries from oil spills[73]. The primary environmental hazards from fossil fuels usage are atmospheric emissions of nitrogen oxides, sulfur dioxide, particulates, hydrocarbons, heavy metals and carbon dioxide. While all are significant pollutants, carbon dioxide is the primary global warming pollutant[74]. Technological changes have mitigated much of this damage with the installation of scrubbers and bag-houses and the burning of low-sulfur clean coal to remove particulates and acid gases, but little has been done to reduce carbon dioxide emissions. Even as U.S. energy consumption increased by 42%, vehicle miles increased by 140% and coal consumption by 100%, key air emissions decreased by 31%.[75] Carbon dioxide emissions from energy use, however, are projected to increase on average by 1.5 percent per year from 2003 to 2025, to 8,062 million metric.[76] New carbon dioxide mitigation programs such as increases in energy efficiency and enhanced conservation, more rapid improvements in technology such as carbon sequestration, or more rapid adoption of voluntary programs such as reforestation could result in lower emissions levels than projected here. Despite this "good news", fossil-fueled power plants, and petroleum fueled vehicles remain a significant source of air pollution, particularly for greenhouse gas emissions.

Renewable or alternative energy technologies are often proposed as a solution to the environmental challenges caused by fossil fuel sources. Typically, the term "renewable energy technologies" refers to wind, biofuels, geothermal, solar thermal, and photovoltaic. Various authors include or exclude hydroelectric and nuclear in their definitions of renewable energy. Hydrogen fuels are viewed as a future renewable energy source. In 2003, electricity renewable sources provided a little more than 6% of the U.S. total[77]. The combination of ever-present technological advances and financial incentives has the potential to dramatically increase the use of these renewable energy sources in our national energy portfolio.

Wind

An old Chinese proverb says: "When the wind of change blows, some build walls, others build windmills".[78] Wind can generate electricity which can be used to charge batteries, pump water, and grind grain. "Large modern wind turbines operate together in wind farms to produce electricity for utilities. Small turbines are used by homeowners and remote villages to help meet energy needs". [79] There are several basic wind technologies: Horizontal Axis Turbines, Vertical Axis Turbines, and Windmills. The Horizontal have two or three blades and are connected to a generator, controller, and

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[73] National Energy Policy, 2003. www.doe.org. Page 3-3.
[74] Morrison, Katherine. "Towards a New Energy Future. How Clean Energy Solutions Reduce Global Warming and Save Consumers Money". U.S. PIRG Education Fund. July 2004. Page 2.
[75] National Energy Policy, 2003. www.doe.org. Page 3-3.
[76] Energy Information Administration, US Department of Energy, *Annual Energy Outlook 2005, Market Trends - Carbon Dioxide Emissions*, retrieved from: http://www.eia.doe.gov/oiaf/aeo/emission.html, 31 May 2005
[77] Energy Information Administration, Department of Energy, "Renewable Energy Trends 2003", p1, retrieved from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/trendsov.pdf, 31 May 2005
[78] EUFORES. "European " Available March 3, 2005 at http://www.eufores.org/
[79] U.S. DOE. "Energy Efficiency and Renewable Energy- Wind Technology." US DOE EERE Home Page. Available March 3, 2005 at http://www.eere.energy.gov/RE/wind_technologies.html

other components. These are the most common in use today. Windmills are not a new technology and have been used 'since at least 200 B.C. for grinding grain and pumping water[80]. Wind is good for the environment because there are minor impacts. The cost of wind energy is low and has dropped approximately 85% in the last 20 years. "Incentives like the Federal production tax credit and net metering provisions available in some areas improve the economics of wind energy".[81] In 2003, wind provided about 2% of the total US energy produced, approximately 2 Quad BTUs.[82] Wind farms are considered environmentally friendly in that they are not the source of any major pollutants. However, some stakeholders express concern about the aesthetics of looking out into a serene ocean or field filled with giant spinning blades. There are also some obvious hazards for migrating birds.

Biofuels

The manufacturing of biofuels yields environmental advantages right from the start as growing the biofuel feedstock such as corn for ethanol or soybeans for biodiesel uses CO_2. "Biofuels contain essentially no sulfur, trace metals or aromatics. They also improve urban air quality and can reduce CO_2 emissions by 78% for biodiesel or 68% for cellulosic ethanol".[83] If proper farming techniques are employed, biofuel manufacturing could ameliorate soil erosion and prevent depletion of biodiversity, and groundwater pollution[84]. The potential to use biomass (crop, animal by-products) converted to biofuels, such as ethanol, and biodiesel is in its infancy in the United States primarily due to a lack of market demand. Compare this to Brazil, which has used ethanol for over 29 years. In 2003 alone, Brazil's ethanol program provided 700,000 jobs and cut oil imports by approximately $50 billion (2000 U.S.$)[85].

Geothermal

Geothermal energy technology uses the heat from the earth directly for geothermal heat pumps and electrical power production. Most of the geothermal resources in the US are found in the western half of the country, but there are other resources in the world. Current research is focused on lowering the cost of producing energy for human consumption. The two primary uses for geothermal use are using geothermal heat pumps to provide heat, cooling for buildings, and taping into the underground reservoirs of hot water or steam to generate electricity.[86]

Solar Thermal

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[80] Ibid
[81] Ibid
[82] Energy Information Administration, Department of Energy, "Renewable Energy Trends 2003", p1, retrieved from: http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/trendsov.pdf, 31 May 2005
[83] Lovins, Amory B. et al. "Winning the Oil End Game. Innovations for Profits, Jobs and Security". Rocky Mountain Institute, Snowmass, CO. 2004. Page 108.
[84] Ibid. Page 109.
[85] Ibid. Page 105.
[86] U.S. DOE. "Energy Efficiency and Renewable Energy." US DOE EERE Home Page. Available March 3, 2005 at http://www.eere.energy.gov/

Each year, the sun's energy directed to the earth is equal to more than 10,000 times the amount of energy that humans currently use.[87] Not surprisingly, humans have been trying for over the last 100 years to harness the sun's rays to produce energy. Solar thermal energy is created when technology captures the sun's heat to create steam to operate an electric generator. Solar energy is 100% "green", except that significant energy, typically from fossil fuels are needed to produce the solar panels bringing into question effective utilization of solar energy in industrial/commercial applications. Additionally, current solar thermal applications require large areas to be commercially competitive, possibly consuming fragile ecosystems.

Photovoltaic

Photovoltaic or PV energy is created when sunlight strikes a PV cell, which in turn excites electrons and generates an electric current. The original science behind PV began more than 150 years ago with the discovery by Alexandre Edmond Becquerel of the photovoltaic effect, the production of energy from the sun.[88] Real application of the technology did not occur until the 1950s with the Bell Labs development of the first crystalline silicon PV cell. The first Bell Labs cell had an efficiency of 4%.[89] Today PV cells have efficiency in the range of 12-18%.[90] The first PV space applications were to power satellites. Like other renewable energy sources, PV energy is characterized by high initial capital costs. High initial costs can make PV unattractive in the short-term, especially in competitive markets.[91] However, because PV systems tend to be durable and have few, if any moving parts, they tend to have low operations and maintenance costs. The low operations and maintenance costs make PV relatively more competitive over the long-run.[92],[93]. PV systems also tend to be very simple and reliable and thus, are often well suited for remote locations ranging from third-world countries to highway call boxes. Since 1993, global PV production grew at 28% per year.[94] Today, worldwide "PV module production is roughly 1GW, which translates into a $1B/year business."[95]

Hydropower

There are three ways in which hydropower facilities in the US generate power for households. The *Impoundment* method uses dams to store river water in a reservoir. Water is released to meet changing electricity needs. A *Diversion* diverts water from a river through a canal or penstock to bring water to the energy creating technology. Hydropower is an important form of renewable energy and is considered by the US Department of Energy to be the largest source of renewable power. Hydropower captures

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[87] Sawin, Janet, *Mainstreaming Renewable Energy in the 21st Century*, Worldwatch Institute, Washington DC, 2004, #169, p.22.
[88] Solarexpert.com, www.solarexpert.com/pvbasics2.html
[89] About.com, www.inventors.about.com/library/inventors/blsolarcar.com
[90] Environmental Science and Technology Online, http://pubs.acs.org/subscribe/journals/esthag-w/2004/September/tech/jt_nano.html
[91] Berinstein, Paula, *Alternative Energy Facts, Statistics and Issues*, Oryx Press, Westport CT, 2001, p.34
[92] Department of Energy, www.eere.energy.gov/consumerinfo p.4-1
[93] Berinstein, Paula, *Alternative Energy Facts, Statistics and Issues*, Oryx Press, Westport CT, 2001, p.34
[94] Sawin, Janet, *Mainstreaming Renewable Energy in the 21st Century*, Worldwatch Institute, Washington DC, 2004, #169, p.22.
[95] Department of Energy, www.eere.energy.gov/consumerinfo p.4-1

the energy of flowing water and turns it into electricity. Currently, the US is getting about 10% of its electricity from hydropower. There are drawbacks with hydropower however: current hydropower technology, while essentially emission-free, can have undesirable environmental effects, such as fish injury and mortality from passage through turbines, as well as detrimental effects on the quality of downstream water. Varieties of mitigation techniques are in use now, and environmentally friendly turbines are under development.[96]

Nuclear Energy

Despite its potential to reduce US dependence on foreign fossil fuels and US greenhouse gas emissions, safety, security, proliferation, and waste disposal concerns have tempered the potential growth of the nuclear power industry. These concerns have risen substantially since 9/11, leading to increasing costs and licensing issues. As a result, the growth of the nuclear power industry predicted in the 1970s has not lived up to expectations. In fact, nuclear power has not grown as a percentage of U.S. energy generation for many years.[97] "One-fifth of the nation's electricity is generated by nuclear power. Nevertheless, the nuclear power industry has no plans to build new nuclear reactors, and the licensing process is so laborious and uncertain that the industry is focusing exclusively on re-licensing its current facilities. Significant, dramatic changes in the outlook for nuclear energy would require major progress on safety, security, proliferation, waste disposal, and licensing issues. The U.S. government is pursuing efforts to address these issues. The first major program is the construction of the nuclear waste repository at Yucca Mountain, Nevada to store the nation's nuclear waste. A second, less visible, and longer-term effort to reinvigorate the industry is underway to develop new, proliferation-resistant nuclear reactors. If successful, such designs would increase the safety, security, and proliferation concerns associated with nuclear power and decrease the risk of countries developing nuclear weapons under the guise of civilian nuclear power reactors.

Hydrogen

Hydrogen can play a critical role in an environmentally conscious economy, as its only byproduct is water. Hydrogen can be produced from thermal, electrolytic, or photolytic processes applied to fossil fuels, biomass, or water[98]. Hydrogen produced from renewable sources has no carbon emissions. In addition, hydrogen produced from fossil fuels can assist in the management of carbon through a process called carbon sequestration, further enhancing it's desirability as an environmentally friendly fuel source.[99] Hydrogen is the fuel of the future both at home and abroad. It has the support of the Bush administration as evidenced by the 2003 State of the Union address in which

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[96] Ibid

[97] Nuclear share of net electricity generation has remained between 18-20% each year from 1990 - 2001. Source: Energy Information Administration, http://www.eia.doe.gov/emeu/mer/pdf/pages/sec8_3.pdf.

[98] Toward a More Secure and Cleaner Energy Future for America. A National Vision of America's Transition to a Hydrogen Economy-To 2030 and Beyond. Based on the results of the National Hydrogen Vision Meeting. Washington D.C. November 15-16, 2001. United States Department of Energy. February 2002. Chapter 2, Page 1.

[99] Ibid. Chapter 3, Page 19.

the President committed $1.2 billion to a Hydrogen Fuel Initiative. If hydrogen is going to succeed, both the public and private sectors need to back the research, development, and deployment of hydrogen fuels cells.

Summary

Increased reliance on fossil fuel as the primary energy source will exacerbate existing environmental problems and potentially cause global climate change with uncertain consequences. These consequences can be mitigated by moving the world energy supply from a fossil fuels towards a greener, renewable portfolio while maintaining economic growth.

CONCLUSION AND RECOMMENDATIONS

Several key recommendations emerged from the lessons learned throughout our energy study and its application to Australia and California.

The first recommendation is that while government regulation is essential, it must be conducted carefully, in line with market incentives. Investment should be a key consideration. Regulators must allow market forces to drive and encourage investment decisions within broad guidelines. In Australia, the power industries have continued to invest in infrastructure subject to approval by the regulators who are not beholden to political forces seeking to minimize tax burdens to meet short term, political goals.

The USG should create market incentives to encourage investment, development, and deployment of a broad portfolio of renewable alternative energy supplies and enhanced conservation measures to reduce US reliance on imported energy and reduce the environmental consequences of the US energy usage. Market incentives should help determine the most efficient portfolio from among such technologies as clean coal, solar, wind, hydrogen, deep earth, nuclear, and other technologies. In the next ten to twenty years, such measures can begin to reduce the growth of U.S. foreign energy dependence and could ultimately eliminate such dependence in the long-term if sufficient resources are devoted to develop alternative energy resources today.

As privatization of the U.S. and international energy market progresses, the USG should integrate its regulatory framework with energy market incentives to encourage investment in the domestic energy infrastructure to meet U.S. and international security and environmental goals. In particular, the U.S. must increase investment in electrical transmission networks, and oil and natural gas pipelines, while harmonizing boutique gasoline standards.

The USG should develop additional regulatory mechanisms to increase reliability, security, and environmental standards for US energy suppliers to minimize the potential impacts of natural disasters, terrorism, or economic disruption while using market incentives to control cost growth.

The USG should participate in international efforts to insure sufficient supplies of affordable, reliable, secure, and environmentally conscious energy resources are available to support the continued economic development of the industrialized and emerging economies.

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